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SURVIVAL AND MOVEMENTS OF RELEASED REHABILITATED BALD EAGLES

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ABSTRACT.—Nineteen Bald Eagles (*Haliaeetus leucocephalus*) which had been injured and successfully rehabilitated were released and radiotracked to determine survival, movements and breeding attempts. The birds were released during the winter months of 1987–1990 along the Mississippi River in Minnesota. Survival of 13 eagles (68.4%) for more than six weeks after release was documented as was mortality for three. One released female nested for three years following her release and produced one chick in each of two of those years. Rehabilitated Bald Eagles can be successfully released into appropriate habitat where they will survive and breed, contributing to the conservation of the species.

Sobrevivencia y movimientos de Águila Cabeciblanca rehabilitada y puesta en libertad

EXTRACTO.—Diecinueve Águilas Cabeciblancas (*Haliaeetus leucocephalus*) que habían sido lastimadas, después de ser rehabilitadas exitosamente, fueron puestas en libertad; su sobrevivencia, sus movimientos y sus intentos de reproducción, han sido luego determinados por medio de radiocontrol. Las aves fueron sueltas durante los meses de invierno de 1987–1990, a lo largo del río Mississippi en Minnesota. La sobrevivencia de 13 águilas (68.4%) por más de seis semanas, después de ser sueltas; así como la muerte de dos, han sido documentadas. Una águila hembra de este grupo anidó por tres años seguidos, inmediatos a ser puesta en libertad, y en los dos últimos de esos años produjo una cría por año. Águilas Cabeciblancas rehabilitadas y sueltas en hábitats apropiados, sobrevivirán y se reproducirán, contribuyendo así a la conservación de la especie.

[Traducción de Eudoxio Paredes-Ruiz]

Rehabilitation and release of injured wildlife has become a widespread activity over much of North America with over 2500 permitted wildlife rehabilitators in the United States alone (E. Thrune, pers. comm.). While exact figures are not available, it can be assumed that many permittees handle birds of prey. One of the underlying goals of raptor rehabilitation is for a released bird to survive and resume "normal" activities. Most importantly, it is assumed, these birds become part of the breeding population, thus contributing to the conservation of their species (Fraser and Moss 1985).

Unfortunately, little effort has been made to document survival, or breeding success of released rehabilitated raptors. This information is critical when assessing the value of rehabilitation to the conservation of populations (Fraser and Moss 1985). Duke et al. (1981) documented nesting by two released rehabilitated Bald Eagles (*Haliaeetus leucocephalus*) one and two years, respectively, after release. They also reported on band returns and incidental sightings of other raptors released from the University of Minnesota. Servheen and English (1979), reported on the movements of color-marked, rehabilitated Bald Eagles in the Pacific Northwest. Radiotelemetry was used by Hamilton et al. (1988) to monitor the survival of eight Red-tailed Hawks (*Buteo jamaicensis*) and one Red-shouldered Hawk (*Buteo lineatus*) in Louisiana.

Our study monitored the survival, movements, and breeding attempts of rehabilitated Bald Eagles released during winter (Nov.–March) from The Raptor Center at the University of Minnesota (TRC). Since 1974, TRC has treated over 630 Bald Eagles for a variety of ailments including fractures, soft tissue injuries, poisoning, and disease. Over 50% of the eagles admitted to TRC have been released to the wild.

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Table 1. Admission and release information for released rehabilitated bald eagles held at The Raptor Center at the University of Minnesota 1987–1990.

CASE NUMBER	AGE	SEX	CAUSE OF INJURY	TYPE OF INJURY/ TREATMENT	DAYS IN CLINIC	RELEASE SITE	RELEASE DATE	DAYS TRACKED	MAX. DIST. TRAVELLED (KM)
N-370	Ad	M	Tp	Toe	23	CNC	22/11/87	126	30
N-374	Ad	F	Tp	Halux/amputation	38	CNC	06/12/87	80	500
N-415	Sub	F	Tp	Toe/amputation	25	PEI	15/12/87	854	—
N-408	Ad	F	Tp	Toe/amputation	30	PEI	15/12/87	71	—
N-390	Sub	U	Tp	Halux/amputation	42	PEI	18/12/87	67	610
N-263	Juv	M	Cv	Starvation	122	CNC	20/12/87	2	—
N-369	Juv	U	Pr	Wing fracture (ulna)	90	PEI	25/01/88	52	16
O-002	Ad	M	Tp	Toe/amputation	40	PEI	12/02/88	6	16
M-209	Juv	U	Mt	Wing soft tissue inj.	522	PEI	12/02/88	66	—
O-103	Sub	F	Mt	Unable to fly	184	CNC	08/11/88	29	129.6
O-430	Sub	M	Pr	Wing fracture (ulna)	55	CNC	11/12/88	1	25.6
O-335	Sub	U	Mt	Starvation	498	CNC	06/11/89	172	40
P-353	Ad	F	Mt	Wing fracture (ulna)	132	CNC	08/11/89	63	10.4
P-271	Ad	F	Mt	Unable to fly	139	MI	01/12/89	—	—
O-414	Juv	U	Pr	Wing fracture (ulna)	420	CNC	05/12/89	143	53
P-439	Juv	F	Mt	Wing fracture (ulna)	51	CNC	11/12/89	102	12
P-412	Sub	F	Pr	Wing fracture (humerus)	85	CNC	05/01/90	111	21
P-452	Sub	M	Pr	Wing fracture (ulna)	79	CNC	17/01/90	48	19
P-506	Juv	U	Mt	Coracoid fracture	79	CNC	12/02/90	29	55

[1] Tp = leg hold trap injury, Pr = projectile injury, Mt = miscellaneous trauma, Cv = collision with vehicle.

METHODS

Nineteen Bald Eagles admitted to TRC with injuries including wing fractures, starvation, and toe and foot damage from leg-hold traps (Table 1) were selected for use in this study. Injuries were repaired and the birds determined ready for release using standard TRC rehabilitation techniques described elsewhere (Redig et al. 1983, Martell and Redig 1985, Chaplin et al. 1989, Chaplin 1989). Amount of time each bird spent in treatment at TRC varied widely, from 23 to 522 d ($\bar{X}$ = 139.7, N = 19) and was related to the nature of the injury. Fourteen birds were sexed using morphometric measurements (Garcelon et al. 1985), and all birds were aged using eye and beak color and plumage characteristics (first year birds = juvenile, subadult, and adult) using the characteristics described by Stalmaster (1987).

Eagles were released between November and February, 1987–1990 (Table 1) at release sites chosen for their location within Bald Eagle wintering habitat (Millsap 1986, Dunstan 1987) and known local use by Bald Eagles (Lane et al. 1986, Anonymous 1987, Dunstan 1987). Twelve eagles were released at the Carpenter St. Croix Valley Nature Center (CNC) on the St. Croix River, two miles north of the confluence of the Mississippi and St. Croix Rivers. Six birds were released at Pigs Eye Island (PEI) located on the Mississippi River south of Holman Airfield in St. Paul at river mile (rm) 834. One bird was sent back to its point of recovery near Saginaw, Michigan. Both the PEI and CNC locations are regular winter TRC Bald Eagle release sites.

All released eagles were marked with a standard U.S. Fish and Wildlife Service aluminum leg band. Nine birds were fitted with white, wrap-around patagial markers (Young and Kochert 1987) alpha-numerically coded with orange herculite sewn onto the dorsal and ventral sides. Use of patagial markers on adult birds was discontinued after the first year and on immature birds after the second year due to concerns about the effects of wing tags on avian reproduction rates (Kinkel 1989), and our own observations of patagial injuries due to marker use.

Ten birds were fitted with a tail-mounted radiotransmitter operating in the frequency range 164.010 and 164.250 KHz (Advanced Telemetry Systems, Bethel, Minnesota) with an expected battery life of 120 d. The radio was attached to a central rectrix by tightening a clamp around the base of the feather shaft and the 17.6 cm antenna was secured to the feather with surgical thread. Both the radio and the antenna were also secured with epoxy glue. The total package weighed 25 g.

Nine birds were fitted with backpack mounted transmitters (Communication Specialists, Orange, California) with an expected battery life of three years. The radio was attached with a teflon ribbon running over the bird's shoul-

ders and under its wings (Kenward 1987) with the antenna resting freely along the dorsal surface of the bird. The total package weighed 90 g.

Radio signals were located from the ground and from a fixed wing aircraft with a Model CE 12 portable receiver (Custom Electronics, Urbana, Illinois) with a three-element collapsible yagi antenna, and later two Cedar Creek Model 2000 programmable scanning receivers with four-element yagi antennas. Air tracking was done with a scanning receiver connected via a switch box to two, four-element yagi antennas affixed to the wing strut of a Cessna 152 or 172 aircraft (Gilmer et al. 1981).

Daily radio triangulations were attempted on each bird for the first 10 d after release and at least once a week for as long as the bird was north of the Minnesota-Iowa border. Weekly flights along the St. Croix and Mississippi Rivers south to the Minnesota-Iowa border were made from November through March to census wintering Bald Eagles and locate radio-tagged eagles. Four additional flights to locate birds were made between December 1987 and March 1988 in central and western Minnesota, and to St. Louis, Missouri and Omaha, Nebraska. Tracking was discontinued around 15 April each year. Relocations were plotted on 1:24 000 U.S. Geological Survey or U.S. Army Corp of Engineers Navigation maps. Comparisons between groups of birds were made using Student's *t*-test.

RESULTS

Nineteen eagles were released during this study: seven juveniles, five subadults, and seven adults. There were eight females, six males and five birds of undetermined sex (Table 1). Six birds (31.6%) had toe injury or loss, eight (42.1%) had wing fractures, three (15.8%) were unable to fly due to soft tissue damage or unknown causes, and two (10.5%) were starving at the time of their admittance.

A total of 356 radio-relocations were obtained from 18 eagles during the three-year study ($\bar{X}$ = 19.8, range 1–63). No band recoveries were reported to us through the Bird Banding Lab. Patagial markers were useful in identifying individuals that were in groups of eagles but did not provide any additional sightings.

Fifteen eagles (78.9%) survived for at least 10 d after release and 13 eagles (68.4%) survived over 6 wk after release. The longest known survivor was a female (P-415, Table 1) for whom near continuous relocations were obtained for 835 d after release. If we had contact beyond 10 d after release, we were able to maintain contact for an average of 134.2 d (N = 15). The same female (P-415) nested for three years following her release on Pigs Eye Island. Fertile eggs were laid in 1988, but the nest was blown down in a windstorm about 10 d after incubation started. The pair successfully fledged one chick in both 1989 and 1990.

Mortality was recorded for three released eagles. A bird (O-103, Table 1) released on 8 November 1988, was caught in a leg-hold trap 29 d later, 129.6 km from the release site. The bird was readmitted to TRC, however, the extent and nature of the injuries necessitated euthanasia. Based on the length of the bird's survival and generally good physical condition, we considered this bird as "successfully released." The second mortality (P-271, Table 1) was recorded of a bird released at Saginaw, Michigan on 1 December 1989. The carcass of this bird was found in early January 1990 and we did not consider this bird successfully released. The third mortality occurred in December 1990 to a bird (P-506, Table 1) released in February 1990 at CNC. The bird was recovered near Blind River, Ontario approximately 800 km northwest of the release site. The cause of mortality in this successfully released bird was Pb poisoning (B. Hunter, pers. comm.).

Signals from four eagles (21%) were lost within 10 d of release. One bird (discussed above) was found dead; the fate of the other three is unknown. All three of these birds were wearing tail-mounted transmitters. We did not lose contact with any eagles fitted with backpack style transmitters.

All relocations occurred along the Mississippi or St. Croix Rivers and associated waterways. Of 15 birds tracked for more than two d, 12 stayed within 5 km of the release site for at least three d after release, and the other three were found within 10 km of their release site for at least five d following release.

The greatest distance eagles were radiotracked from their release sites ranged from 2–610 km ($\bar{X}$ = 107 km, SD = 194 km, N = 14). Birds released during the first year of the study traveled farther ($\bar{X}$ = 168 km) than the birds released during the third year of the study ($\bar{X}$ = 30 km; t = 1.37, $P > 0.1$, df = 12). Lack of data prevents comparisons to year two of the study. There was no significant difference in travel distance between males ($\bar{X}$ = 22 km, N = 4) and females ($\bar{X}$ = 99 km, N = 6) or between adult ($\bar{X}$ = 112 km, N = 5) and immature birds (subadults and juveniles) ($\bar{X}$ = 89.2 km, N = 11).

DISCUSSION

We have shown that Bald Eagles can be treated for a variety of injuries, using proper veterinary and rehabilitation techniques, and survive after release in appropriate habitat. Furthermore, we have documented that rehabilitated Bald Eagles can repro-

duce, and will seemingly integrate back into the larger Bald Eagle population.

Injuries to eagles used in this study were representative of injuries seen in all eagles admitted to TRC. Most injuries were severe and in five cases required amputation of a digit. Four eagles including the breeding female and two birds (one adult, one subadult) who traveled the greatest distance survived more than 9 wk. This indicates that both immature and adult Bald Eagles can adapt successfully to the surgical loss of a digit reinforcing the importance of immediate, proper treatment of leg-hold trap injuries in Bald Eagles. Seven released eagles were treated for fractures, and were able to resume normal functions in the wild.

Our findings that eagles remained near release sites for the first few days after release are similar to what Hamilton et al. (1988) found with Red-tailed Hawks in Louisiana. Servheen and English (1979) also noted that the Bald Eagles they released remained in the local area for 3–4 d. They attributed this to poor muscle condition. Birds released in this study were exercised regularly (Chaplin 1989, Chaplin et al. 1989) and we considered their flight condition excellent.

The tendency of released raptors to remain in the release area is important for rehabilitators to consider when choosing release sites. Release locations should be capable of satisfying the immediate needs (particularly food and shelter) of the bird for at least 3–5 d after release. Choosing a release site where the bird may be in competition with others, is forced to fly a great distance, or is marginal habitat may disadvantage the newly released bird.

Movements by released individuals were always along river corridors and followed seasonal patterns expected of wintering Bald Eagles in the upper Midwest (Dunstan 1987), an indication the birds had adjusted to release. Longest distance traveled by one of our birds (610 km) was greater than the 364 km reported by Duke et al. (1981) or the 332 km reported by Servheen and English (1979). This most likely reflects both the length of the Mississippi River wintering grounds and the amount of relocation effort expended in this study. Eagles released in the first year of the study traveled farther than in the third year which we attribute to severe weather in the winter of 1987/88. Larger portions of the Mississippi River bordering Minnesota were frozen, reducing the amount of food available to eagles, forcing them to move farther south.

Survival, movements on the wintering grounds, and reproductive success of released rehabilitated Bald Eagles shows that the time and money spent on rehabilitation can result in returning healthy, reproductively fit individuals back into the population. Impacts on the conservation of the population will depend on number, age, and possibly sex of released birds. Further work is needed in looking at the success rate associated with particular injuries and diseases, especially lead poisonings and exposure to other toxic chemicals.

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